Appendix A: Course Schedule

for the study programme Product-Service Engineering (work-integrated) B.Eng.

Please note: The German version of this document is the legally binding version. The English translation provided here is for information purposes only.

First semester			L	ST	E	P/S	SSS	CP
Module number	Module title	Module ID						
3102	Electrical Engineering I	ELO1	1	0	3	0	1.5	5
3132	Fundamentals of Business Administration	GBW	2	0	2	0	1	5
3353	Foundations of Computer Science	GDI	2	0	1	1	1.5	5
3218	Mathematics I	MATH1	2	0	2	0	1	5
3310	Product-Service Engineering – Introduction and Overview	PSE	2	0	1	1	1.5	5
							Total CP:	25
Second semester			L	ST	E	P/S	SSS	CP
Module number	Module title	Module ID						
3019	Databases	DUD	2	0	1	1	1.5	5
3105	Electrical Engineering II	ELO2	2	0	1	1	1.5	5
3311	Principles of Mechanics	GME	2	0	1	1	1.5	5
3257	Mathematics II	MATH2	2	0	2	0	1	5
3267	Object-Oriented Programming	OOP	2	0	1	1	1.5	5
							Total CP:	25
Third semester			L	ST	E	P/S	SSS	CP
Module number	Module title	Module ID						
3254	HMI and User Interfaces	HMI	2	0	2	0	1	5
3256	Cost Accounting/Product Costing	KRPK	2	0	2	0	1.5	5
3258	Mathematics III	MATH3	2	0	2	0	1	5
3266	Metrology/Sensors	MTSO	2	0	1	1	1.5	5
3112	Practical Module I	PX1	0	0	0	0	0	5
3121	Technical English	TCE	2	0	0	2	1	5
							Total CP:	30
Fourth semester			L	ST	E	P/S	SSS	CP
Module number	Module title	Module ID						
3253	Basics of Mechanical Design	GDK	2	0	2	0	1	5
3117	Industrial Control Technology	IST	2	0	1	1	1.5	5
3125	Feedback Control Engineering	RTK	2	0	1	1	1.5	5
3260	Service Engineering	SVE	1	0	3	0	1.5	5
3224	Statistics	STAT	2	0	2	0	1	5
							Total CP:	25
Fifth semester			L	ST	E	P/S	SSS	CP
Module number	Module title	Module ID						
3211	Innovation and Project Management	IPM	2	0	2	0	1	5

3122	Practical Module II	PX2	0	0	0	0	0	5
3264	Networking and IoT Solutions	IOT	2	0	1	1	1.5	5
9017	Elective Module: Product-Service Engineering	WM				0		5
9017	Elective Module: Product-Service Engineering	WM				0		5
							Total CP:	25

Sixth semester			L	ST	E	P/S	SSS	CP
Module number	Module title	Module ID						
3129	Practical Module III	PX3	0	0	0	0	0	5
3309	Product Development and Requirements Engineering	PQRE	2	0	2	0	1.5	5
3259	Safety and Security	SAS	2	0	1	1	1.5	5
9017	Elective Module: Product-Service Engineering	WM				0		5
9017	Elective Module: Product-Service Engineering	WM				0		5
							Total CP:	25

Seventh semester			L	ST	E	P/S	SSS	CP
Module number	Module title	Module ID						
3133	Bachelor Thesis	BA	0	0	0	0	0	12
3252	Diagnosis and Predictive Maintenance	DPM	2	0	2	0	1	5
3134	Colloquium	KOL	0	0	0	0	0	3
3255	Sales and Customer Management	VUK	2	0	2	0	1	5
							Total CP:	25

Abbreviations of the teaching forms: L = lecture, ST = tuition in seminars, E = exercise, S = seminar, P = practical, SSS = supervised self-study (all data in semester credit hours);
CP = credit points
W/S = winter/summer semester

Elective Modules Product-Service Engineering									
Module number	Module title	Module ID	W/S	L	ST	E	P/S	SSS	CP
3204	Data Analytics	DML	W	2	0	1	1	1	5
3255	Maintenance and Spare Parts Management	IEM	W	2	0	2	0	1	5
3340	Machine Learning	ML	S	2	0	1	1	1	5
3201	Quality Management	QMG	S	2	0	2	0	1	5
3261	Service Communication and Training Concepts	SKTK	S	2	0	2	0	1	5
3262	Smart Services and Devices	SMSD	W	2	0	2	0	1	5
3263	Usability Engineering	UEG	S	2	0	2	0	1	5
3265	Contract and Liability Law	VHR	W	2	0	2	0	1	5

Appendix B: Module catalogue

for the study programme Product-Service Engineering (work-integrated) B.Eng.

Bachelor Thesis					BA
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3133	360 h	12	7th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	360	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	After successfully completing the bachelor thesis, students are able to independently work on and appropriately present a practice-oriented task from their special subject area, both in the subject-specific details and in the interdisciplinary contexts, using scientific methods within a specified period of time.	
3	Contents:	
	The bachelor thesis is an independent scientific work from the subject area of the respective study programme with a description and explanation of its solution. It can be derived from current research projects at the university or from operational problems with an engineering character. It can also be determined by an empirical investigation or by conceptual or design tasks or by an evaluation of existing sources. The different forms can be combined.	
4	Forms of teaching:	
	Written composition with faculty tutoring	
5	Participation requirements:	
	Formal:	-
	Content:	Coordinated topic from the student’s special subject area
6	Forms of assessment:	
7	Prerequisite for the award of credit points:	
8	Application of the module (in the following study programmes)	
	Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics /Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	N. N.	
11	Other information:	
	-	
12	Language:	
	German	

Data Analytics					DML
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3204	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	54	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- know and master the basic concepts and methods of data analysis and statistical learning.
- are able to access internal and external data sources.
- can understand the procedures for classification, modelling and prediction on the basis of large data sets and apply them to examples.
- master the basic handling of NoSQL databases can describe numerical data by statistical characteristic values and visualise them in a common way.
- are able to analyse large amounts of data in a targeted as well as exploratory manner, whereby a diverse range of methods from the field of statistics and machine learning is available to them.
- are able to understand the basic procedure for analysing very large amounts of data on Hadoop clusters.

3 Contents:

- Introduction and general overview ("Small Data" vs. "Big Data")
- NoSQL database systems
- Tapping data sources
- Basics of programming with Python (which is used in the exercises for practical data analysis)
- Basics of descriptive statistics
- Visualisation of data
- Correlation analysis and regression
- Time series analysis
- Basics of machine learning
- Pre-processing of data (e.g. dimension reduction)
- Unsupervised learning (e.g. clustering)
- Supervised learning I: Classification (e.g. via support vector machines)
- Supervised learning II: Learning of arbitrary input-output correlations (e.g. with artificial neural networks)
- Entry into large-scale data analysis with Hadoop

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Logistics (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information: -	
12	Language: German	

Databases					DUD
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3019	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	68	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	34	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

Students:

- acquire basic knowledge about the architecture, functioning and use of database systems and know the principles of the organisation of a database system
- acquire knowledge about modern (object-oriented) and classical data modelling including the meaning of normalisation rules
- are able to perform a complete relational database design, starting from a requirements specification are proficient in standard SQL to perform simple and complex queries, as well as change operations.
- gain the ability to evaluate and select database technologies
- can plan and implement database projects and develop a modern database application

3 Contents:

- Introduction to database concepts and database technologies (data modelling, normalisation theory, database language SQL)
- Basics of database systems (database design, database definitions, database queries)
- Data Manipulation Language (DML, German "Datenverarbeitungssprache"), Data Definition Language (DDL, German “Datenbeschreibungssprache"), Data Control Language (DCL, German “Datenaufsichtsprache")
- Efficiency of SQL queries, index structures
- Authorisation concepts

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, written examination, combined examination, project work, oral examination or examination accompanying the course

7 Prerequisite for the award of credit points:

Module examination pass and course assessment

8	Application of the module (in the following study programmes) Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Dr. rer. nat. Sabrina Proß
11	Other information: -
12	Language: German

Diagnosis and Predictive Maintenance					DPM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3252	150 h	5	5th or 7th semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

The students know different monitoring models and can describe them. They have acquired basic knowledge of physical and discrete-event modelling and can use the modelling methods to diagnose faults and misbehaviour. They understand the different diagnostic approaches and can use them for specific applications. They have acquired knowledge of the theories of parameter estimation, vibration analysis, data-based analysis of measurement series, etc. and can establish connections between the methods. They develop algorithms for signal analysis and pattern classification and can explain their solutions in technical discussions and justify their approach. They create parity equations and symptom tables and test them on simple faulty processes.

3 Contents:

- Signal-based diagnosis, limit value/trend monitoring
- Trajectory monitoring and plausibility check
- Model-based diagnosis
- Analysis of signal models and process models
- Correlation and spectral analysis
- Parameter estimation
- Parity equations
- Condition monitoring
- Vibration analysis
- Predictive maintenance
- Data-based analysis
- Presentation of selected data mining challenges: Classification, clustering etc.

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

of

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, written examination, project work or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: N. N.
11	Other information: -
12	Language: German

Electrical Engineering I					ELO1
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3102	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	1	SCH	0	h	32	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	3	SCH	24	h	70	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The students have basic knowledge of electrical engineering. The students are able to correctly understand and analyse physical relationships in electricity and to calculate simple circuits and networks for direct current circuits. In addition, they can solve simple field tasks in electrostatics.
They will also know the materials and designs of resistors and capacitors and how to use them in circuitry.
They know how to use homogeneous semiconductors as non-linear components in the DC circuit for required applications.

3 Contents:

- Basic terms and quantities in electrical engineering
- Derivation of the basic equations, Ohm's law
- Simple and branched DC circuits
- Methods for calculating DC circuits
- Electrical energy and electrical power
- The electrostatic field, manifestations and forces
- The capacitor, charging and discharging processes
- Structure and types of resistors and capacitors
- Homogeneous semiconductor components: LDR, PTC, NTC, VDR
- Nonlinear direct current circuits

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	

6 Forms of assessment:

Written examination, combination examination or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Mechatronics/Automation (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Prof. Dr. Werner Schwerdtfeger

11	Other information:
12	Language: German

Electrical Engineering II					ELO2
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3105	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The students have basic knowledge of electrical engineering. They are able to understand and analyse physical relationships in electricity and magnetism. With the help of complex calculation, they can also interpret and calculate demanding circuits from the AC range.
In addition, they can solve simple tasks on the magnetic field. They will also know the materials and designs of coils and transformators and know how to use them in terms of circuitry.

3 Contents:

- The static and time-variant magnetic field
- Calculation of magnetic circuits
- Induction law and inductance
- Basic concepts of alternating current technology
- Description of alternating variables with the aid of complex calculation
- Procedure for calculating alternating current circuits
- Locus curve and floor diagram
- Power in an AC circuit
- Improving the power factor
- The transformer
- Construction and designs of coils and transformers

4 Forms of teaching:

Learning units for self-study, classroom events in the form of exercises and practicals

5 Participation requirements:

Formal:	-
Content:	

6 Forms of assessment:

Written examination, combination examination or oral examination

7 Prerequisite for the award of credit points:

Module examination pass and course assessment

8 Application of the module (in the following study programmes)

Mechatronics/Automation (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Prof. Dr. Werner Schwerdtfeger

11	Other information: -
12	Language: German

Fundamentals of Business Administration					GBW
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3132	150 h	5	1st or 3rd semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

The students know the basic organisational structures and the optimisation tasks of companies as well as the basic principles and success criteria of economic action. This enables them to classify their own engineering activities in the operational and business context and to assess and control the economic consequences/effects of their activities. In this sense, the module provides the basic business knowledge and the basic structures for interdisciplinary thinking and action.

3 Contents:

- Classification, development and basic concepts of business administration
- Basic principles of economic action
- Overview of the most important business functional areas at the level of goods management and finance as well as the cross-functional areas (materials management, production, sales, investment and financing, business accounting (annual financial statements, cost accounting))
- Corporate goals and corporate key figures/key performance indicator systems
- Forms of corporate law and corporate affiliations

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, written examination, project work or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Economist Ulrike Franke

11	Other information: -
12	Language: German

Foundations of Computer Science					GDI
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3353	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

After successful completion of the module, students master the terminology of computer science and have basic knowledge of the functioning of computer systems and computer architectures. The students know selected methods for the description and evaluation of algorithms. They can structure simple information technology problems and develop suitable solutions, as well as justify and defend them. Students have basic knowledge and initial experience in the implementation of algorithms in the programming language C.

3 Contents:

Introduction to Computer Science:

- Terms
- Definitions
- Number systems
- Representation of numbers and characters in the computer
- Methods for describing algorithms with flow charts, Nassi-Shneiderman diagram and pseudo code
- Methods for evaluating the complexity of algorithms

Basics of computer architecture:

- Basic structure of processors
- Instruction cycle in microprocessors
- Memory hierarchy
- Bus systems

Programming in C:

- Conditional instructions
- Loops
- Functions
- Arrays
- Pointers
- Structs
- Working with files

Selected algorithms:

- Sorting algorithms (e.g. bubble sort and quick sort)
- Search algorithms (e.g. binary search)

4	Forms of teaching: Learning materials for self-study, classroom sessions of exercises and practicals	
5	Participation requirements:	
	Formal:	
	Content:	
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr.-Ing. Christian Stöcker	
11	Other information:	
12	Language: German	

Basics of Mechanical Design					GDK
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3253	150 h	5	4th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

The students know the basics of technical drawing, can understand technical drawings and execute simple technical representations. They understand the basic procedure in the design process, know the basics of methodical design and can thus contribute to the design of products. From the application of the fundamentals of strength, the students can recognise essential connections of stress-appropriate design and carry out their own selected strength verifications. They understand the general procedure for the selection of design and machine elements and are able to select different design elements from an understanding of the functional and stress concerns and dimension them.

3 Contents:

General principles of mechanical design:
Design methodology and systematics
Design of components and assemblies
Fundamentals of standardisation
Tolerances, fits, technical surfaces
Technical drawing (types of drawings, structure of technical drawings, representation of components, tolerance specifications in drawings, drawing specifications for technical surfaces)
Introduction to strength of materials:
Tasks of strength theory; external forces and internal stresses; basic types of stress; temporal load progression; strength parameters for material behaviour; influences on component strength; analytical strength calculation.
Selected machine and connecting elements:
Fasteners; bearing and transmission elements; exercises for creating and reading technical drawings as well as for the strength-compliant design of components and for strength verification.

4 Forms of teaching:

Learning units for self-study, attendance events in the form of lectures and exercises

5 Participation requirements:

Formal:	-
Content:	-

6	Forms of assessment: Term paper, written examination, combination examination, performance examination, project work, oral examination or examination during the course
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Mechatronics/Automation (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Klaus Dürkopp
11	Other information: -
12	Language: German

Principles of Mechanics					GME
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3311	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

Students are able to

- describe the basic relationships of statics, as the study of the equilibrium of forces in and on mechanical structures at rest.
- explain geometric and temporal processes of movements, as well as their interactions with forces and moments in and on mechanical structures.
- characterise the basic concepts of dynamics in their physical dimension as well as their technical application.
- describe technical problems from mechanical engineering in the form of physical models.
- apply the principles of virtual work both in statics and in dynamics to solve mechanical problems.

3 Contents:

Basic concepts of mechanics:

- Force – Balance – Rigid Body
- Clearing

Statics:

- Plane central force systems
- Equilibrium on rigid body
- Stability of equilibrium positions
- Centre of gravity
- Principle of virtual work
- Friction

Kinematics and kinetics:

- Dynamics of the mass point
- Kinetics of the plane movement
- Dynamics
- Principle of virtual work in dynamics

Elastostatics:

- Static indeterminate plane systems

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information: -	
12	Language: German	

HMI and User Interfaces					HMI
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3254	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

The students know the principles of human information processing. They can explain and apply methods, guidelines and standards for the design of user interfaces. They are able to implement design principles with the corresponding methods and thus develop user interfaces. They design and model user interfaces and can test them with respect to applicability. They are familiar with the software development process and use it to develop interfaces for operating and interacting with machines.

3 Contents:

- Human information processing (models, physiological and psychological foundations, human sensing, action processes)
- Design basics and design methods
- Basics of input and output for computers, embedded systems and mobile devices
- Principles, guidelines and standards for the design of user interfaces
- Basics for the design of user interfaces (text dialogues and forms, menu systems, graphical interfaces, interfaces in the WWW, audio dialogue systems, haptic interaction, gestures)
- Methods for modelling user interfaces (abstract description of interaction as part of requirements analysis and the software design process)
- Development of user interfaces in an object-oriented programming language

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	Modules "Foundations of Computer Science" and "Object-Oriented Programming"

6 Forms of assessment:

Term paper, written examination, project work or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: N. N.
11	Other information: -
12	Language: German

Industrial Control Technology					IST
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3117	150 h	5	4th or 6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

After successful completion of the course, the students have a basic knowledge of the essential components of an automation system and can select and use them in a solution-oriented manner. They know how conventional and PC-based controls work and can program these controls with different programming languages. They know the basics of bus systems and can name different bus systems and their areas of application. They can formally describe controls as discrete systems by means of automata, Petri nets and UML state diagrams and use these models for the methodical design of logic controllers, sequence controllers, control systems and diagnostic units.

3 Contents:

Introduction to control technology

- Terms
- Definitions

Sensors and actuators

- Standard sensors and their application (inductive, optical)
- Basics of FI and servo technology, pneumatics
- Safety functions (ST0; SS1; SS2; SOS...)

Bus technology

- Basics of industrial communication
- Comparison of different bus systems and their areas of application

Design and structures of industrial controls

- PLC and PC-based control
- Information processing

Structured programming according to IEC 61131

- Graphics- and text-based programming languages
- Basics of object-oriented PLC programming

Linkage controls

- Description of discrete systems by deterministic automata
- Model-based control design
- Practical implementation in ST and UML state diagram

	Sequence controls and schedule controls • Description of discrete systems • Model-based design and practical implementation of the control system Error management • Fault diagnosis and detection • Preventive diagnosis
4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises and practicals
5	Participation requirements: Formal: Content:
6	Forms of assessment: Written exam, project work or oral exam
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Thomas Freund
11	Other information:
12	Language: German

Innovation and Project Management					IPM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3211	150 h	5	3rd/4th/5th/7th sem.	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- are prepared to lead product development and innovation projects and teams to success in terms of holistic and strategically oriented project management (also including agile methods).
- understand the basics of project management and can use the elementary technical vocabulary.
- can explain the most important instruments of project management.
- are able to lead/manage a project in a given process-organisational project organisation.
- are able to develop and specifically use control options for different project phases (controlling of the degree of completion, cost controlling).
- can explain the specifics of team building and project management.
- can carry out the moderation of team meetings projects.
- know instruments of IT-supported project management.
- can explain the importance of corporate objectives and are able to distinguish between different management cultures.
- can name essential aspects of industrial property protection.

3 Contents:

- Basics of project management (terms/methods/instruments)
- Project phase models and planning systems (project preparation, project planning, project implementation, project completion)
- Agile project management
- Forms of project organisation
- Innovation and change management, self-management
- Project planning (project structure plan/cost plan/resource plan/schedule)
- Project documentation/project controlling
- Risk management
- Special features of use of methods in innovation projects

	(Strategic preparation / initiation, planning, monitoring and control of innovation projects) • Leading project and innovation teams (social structures, special communication situations in projects, real and virtual project work, problem analysis and concepts for action) • Stakeholder management (factors influencing the successful management of projects) • Methods of idea generation (creativity techniques etc.) • Trainings and workshops on selected technical examples • Basic aspects of industrial property protection
4	Forms of teaching: Learning units for self-study, classroom sessions in the form of exercises
5	Participation requirements: Formal: - Content: -
6	Forms of assessment: Term paper, written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Michael Fahrig
11	Other information: -
12	Language: German

Maintenance and Spare Parts Management					IEM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3255	150 h	5	5th or 6th semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students demonstrate a comprehensive knowledge and understanding of the scope, characteristics and areas of maintenance. They know the sub-areas of maintenance and can apply the corresponding methods (such as Total Productive Maintenance, Lean Maintenance, Reliability centred Maintenance etc.). Students will be able to develop maintenance strategies. They have a basic knowledge of performance measurement and KPI systems and can transfer this to the processes in the company. Students have detailed knowledge of the planning and organisation of maintenance.
The students have an overview of the different spare parts strategies and can define them. They can create inventory plans and design order processing and its processes. They can explain the basics of materials management and are able to communicate orally and in writing in a technically competent and interdisciplinary manner in the field of maintenance and spare parts management. Furthermore, they assess key figures and can relate them to the maintenance and materials management in their company.

3 Contents:

- Development of maintenance strategies
- Performance measurement and KPI systems

Introduction to modern methods such as:

- Total Productive Maintenance
- Lean Maintenance
- Reliability-centred maintenance

Overview of the different tasks of maintenance management

- Maintenance as a function of a company
- Planning in maintenance
- Spare parts management

Fundamentals of Materials Management:

- Definition of spare parts strategies
- Stock planning, order handling and processes
- Storage and inventory management
- Warehouse organisation and structures

	• Key figures and analyses • Materials management systems • Optimisation of spare parts management • Alternative supply strategies	
4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information: -	
12	Language: German	

Colloquium					KOL
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3134	90 h	3	7th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	90	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	In the colloquium, students demonstrate that they are able to present the results of the bachelor thesis, its subject-specific foundations, its interdisciplinary connections and its extra-curricular references orally and justify them independently. Students can critically question the results of their work and are able to assess their significance for practice.	
3	Contents:	
	The colloquium complements the bachelor thesis and is to be assessed independently. Content of the thesis Disputation on topics such as: the preparation of the thesis and the issues that arose in the context of the thesis.	
4	Forms of teaching:	
	Oral examination	
5	Participation requirements:	
	Formal:	All modules of the study programme must be successfully completed. The bachelor thesis must be successfully completed.
	Content:	Treatment of the bachelor thesis
6	Forms of assessment:	
	Oral examination	
7	Prerequisite for the award of credit points:	
8	Application of the module (in the following study programmes)	
	Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	N. N.	
11	Other information:	
	-	
12	Language:	
	German	

Cost Accounting/Product Costing					KRPK
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3256	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	54	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The students know different cost type calculations and can describe them. They know the basics of modern cost and activity accounting and can establish the connection to external accounting. They have an overview of the methods and systems of classical cost and activity accounting and can point out the interfaces to current controlling instruments. They can explain the basic principles of cost type accounting for personnel, material costs and machine wear and are able to carry them out. They will gain an insight into cost centre accounting to optimise administration and sales overheads and to determine hourly rates for personnel and machinery. They understand the essential principles of cost unit accounting for the calculation of prices by means of overhead calculation including post-calculation and have the knowledge to interpret and carry out these calculations.

They will gain knowledge in the area of direct costing for profit optimisation and breakeven analysis. The students can select appropriate procedures based on fixed and variable cost shares. They are capable of flexible budgeting for future-oriented budgeting and for the analysis of consumption, performance and employment variances.
They have knowledge of how to prepare product launch accounting. They can use ERP systems in the area of cost and activity accounting.
They will gain a basic understanding of the background of production theory and typical operational decision-making problems.

3 Contents:

Basic concepts of cost/activity accounting
Cost-type accounting
Cost centre accounting
Cost unit accounting
Operational accounting sheet (BAB)
Contribution margin accounting
Planned cost accounting
Short-term profit and loss statement
Product launch statement
Planned cost statement
Process cost accounting

	Target costing Service management (e.g. taxes, transfer pricing) Use of ERP system in the area of cost and activity accounting	
4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information: -	
12	Language: German	

Machine Learning					ML
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3340	150 h	5	4th or 6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	54	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

- The students explain the history and basics of machine learning and establish the relationship to its practical applications.
- They master the use of common dimension reduction and feature selection methods in practical application.
- They classify data using classification methods from statistical learning theory (such as support vector machines) and from the field of artificial neural networks. They also use decision trees or discriminant analysis for this purpose.
- They use artificial neural networks to learn mappings between arbitrary input and output data (also for time series).
- They know different methods for parameter determination in artificial neural networks and use them in a targeted manner.
- They explain evolutionary and genetic algorithms and apply them.
- They have a comprehensive overview of machine learning methods and can assess which methods should be used in which application scenarios.
- They develop workflows for machine learning.

3 Contents:

- Basics of machine learning
- Pre-processing of data
- Dimension reduction and feature selection
- Statistical learning theory and kernel methods
- Classification (support vector machines, decision trees, discriminant analysis, etc.)
- Artificial neural networks (self-organising maps, multi-layer perceptrons, recurrent topologies, extreme learning machines, reservoir computing, etc.)
- Method for parameter determination in artificial neural networks
- Evolutionary and genetic algorithms
- Workflows in machine learning
- Practical application examples from industry and the corporate world

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5	Participation requirements:	
	Formal:	
	Content:	• Content of the mathematics modules and statistics • Advanced programming skills in Python
6	Forms of assessment: Written examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information:	
12	Language: German	

Mathematics I					MATH1
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3218	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

The students are familiar with the mathematical working method and have mastered the basic terms and methods from the areas of analysis and linear algebra, which they can also apply to practice-oriented problems from technology, natural science and economics.

3 Contents:

- General basics (set theory, inequalities, propositional logic, methods of proof)
- Functions of one variable (limit and continuity, polynomial functions, rational functions, trigonometric functions, exponential function, logarithm function)
- Differential calculus for functions of one variable (differentiability, derivation rules, applications)

  Linear algebra (vectors, matrices, determinants, systems of linear equations, eigenvalues and eigenvectors)

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written examination, combined examination, oral examination or examination during the course

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics /Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Dr. rer. nat. Sabrina Proß

11 Other information:

-

12	Language: German

Mathematics II					MATH2
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3257	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- can deepen their knowledge in the area of calculus.
- master the essential principles of integral calculus and differential calculus for functions of several variables.
- have an overview of the methods for the analytical solution of ordinary differential equations and systems of differential equations and can apply these to practice-oriented problems.

3 Contents:

- Complex numbers (definition and representation, complex calculus)
- Integral calculus for functions of one variable (fundamental theorem of differential and integral calculus, integration rules, integration methods, improper integrals, applications)
- Differential calculus for functions of several variables (functions of several variables, partial differentiation)
- Ordinary differential equations (differential equations of the 1st order, linear differential equations of the 2nd or nth order with constant coefficients, systems of linear differential equations)

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	- Modules: 3218 Mathematics I

6 Forms of assessment:

Written examination, combined examination, oral examination or examination during the course

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10	Module coordinator: Dr. rer. nat. Sabrina Proß
11	Other information: -
12	Language: German

Mathematics III					MATH3
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3258	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- know the most important numerical algorithms and their possible applications and are able to handle numerical problems and estimate errors of numerical calculations.
- can implement simple algorithms in a higher programming language on a computer.
- can develop functions in power and Fourier series.
- are familiar with the basics and properties of the Fourier and Laplace transform.

3 Contents:

- Numerics (numerical determination of zeros, numerical differentiation, numerical integration, numerical solution of differential equations)
- Power series development (infinite series, power series, Taylor series)
- Fourier series
- Fourier transform
- Laplace transform
- Use of Matlab/C++/Python

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	- Modules: 3218 Mathematics I; 3257 Mathematics II

6 Forms of assessment:

Written examination, combination examination, project work, oral examination or examination during the course

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Mechatronics/Automation (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10	Module coordinator: Dr. rer. nat. Sabrina Proß
11	Other information: -
12	Language: German

Metrology/Sensors					MTSO
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3266	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The students are familiar with the construction and mode of operation of electrical measuring devices and know how to use them in conjunction with the corresponding sensors.
They can analyse metrological problems and find solutions to them. The students have the knowledge to assess the quality (i.e. measurement uncertainties) of the measurement procedures and measurement results.

3 Contents:

Contents:
Basic concepts of measurement technology
Measurement uncertainties
Systematic and random error, error propagation
Measuring instruments and sensors
Electromechanical measuring instruments
Digital measuring instruments
Recording measuring instruments
Sensor technology, conversion of physical quantities into electrical signals
Measurement of electrical quantities
Current and voltage measurement methods
Measurement of R, L, C. Measuring bridges
Measurement of electric and magnetic field quantities
Measurement of mechanical quantities
Length and angle measurement
Strain and force measurement
Speed and velocity measurement
Torque and power measurement
Pressure measurement
Measurement of process variables
Measurement of thermal variables
Flow measurement
Humidity measurement
Measurement of radioactive quantities
Measurement of optical quantities

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6	Forms of assessment: Term paper, written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. Werner Schwerdtfeger
11	Other information: -
12	Language: German

Object-Oriented Programming					OOP
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3267	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

After successful completion of the module, the students have an understanding of object-oriented programming and its distinction from structured programming. They can analyse concrete problems from IT and design and implement suitable solutions in the programming language C++. The students have an overview of selected design patterns and can evaluate and implement their application in given problems. The students have gained knowledge about selected models of the UML and can apply it.

3 Contents:

Introduction to object-oriented programming:

- Fundamental concepts
- Differences between procedural and object-oriented programming

Programming in C++:

- Classes
- Objects and methods
- Operators and operator overloading
- Inheritance
- Templates
- Error handling

Software development:

- Design patterns
- Waterfall model, V-model
- UML (e.g. class diagram and sequence diagram)
- Unit tests

4 Forms of teaching:

Learning letters for self-study, classroom events in the form of exercises and practicals.

5 Participation requirements:

Formal:	
Content:	Structured programming (ideally with C), general informatics basics

6 Forms of assessment:

Term paper, written examination, project work or oral examination

7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Christian Stöcker
11	Other information:
12	Language: German

Practical Module I					PX1
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3112	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	150	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	Students acquire and deepen knowledge and skills specific to the study programme. For this purpose, individual problems are worked on holistically and under practical conditions during the work term at the company and solution options are developed independently. In addition to the professional competence, the students acquire the ability of working scientifically and successively develop it further.	
3	Contents:	
	The topics to be worked on must be related to engineering science and be oriented towards the module contents of the curriculum. The topic is agreed between the student, the supervisor in the company and the examiner at the university of applied sciences.	
4	Forms of teaching:	
	Work-related module	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment:	
	Term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Practical Module II					PX2
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3122	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	150	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	Students acquire and deepen knowledge and skills specific to the study programme. For this purpose, individual problems are worked on holistically and under practical conditions during the work term at the company and solution options are developed independently. In addition to the professional competence, the students acquire the ability of working scientifically and successively develop it further.	
3	Contents:	
	The topics to be worked on must be related to engineering science and be oriented towards the module contents of the curriculum. The topic is agreed between the student, the supervisor in the company and the examiner at the university of applied sciences.	
4	Forms of teaching:	
	Work-related module	
5	Participation requirements:	
	Formal:	Module examination pass in Practical Module I
	Content:	-
6	Forms of assessment:	
	Term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Practical Module III					PX3
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3129	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	150	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	Students acquire and deepen knowledge and skills specific to the study programme. For this purpose, individual problems are worked on holistically and under practical conditions during the work term at the company and solution options are developed independently. In addition to the professional competence, the students acquire the ability of working scientifically and successively develop it further.	
3	Contents:	
	The topics to be worked on must be related to engineering science and be oriented towards the module contents of the curriculum. The topic is agreed between the student, the supervisor in the company and the examiner at the university of applied sciences.	
4	Forms of teaching:	
	Work-related module	
5	Participation requirements:	
	Formal:	Module examination pass in Practical Module II
	Content:	-
6	Forms of assessment:	
	Term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Product-Service Engineering – Introduction and Overview					PSE
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3310	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The students are able to overview the subject area of product service engineering and to name the essential principles of service and service performance management.
They can

- allocate relevant examples of services to the area of hybrid service bundling. Service platforms and various cloud solutions that are used in the area of web services can be distinguished from each other.
- apply simple web-based cloud services.
- describe the process for developing services.
- explain the connections between a product and a service.
- describe the basic idea of the Internet of Things and use it to develop services.

The students have first experiences with different presentation techniques, the preparation of scientific papers and the time management, structuring and managing projects.

3 Contents:

Introduction to the subject area of product-service engineering

- Definition of services and smart services
- Examples of services
- Service and service management at a glance
- Definition of hybrid service bundling
- Overview of service platforms
- Introduction to cloud solutions
- Introduction to service development
- Networking, digitalisation and the Internet of Things as the basis for services
- Application of web-based cloud services.

Introduction to scientific work in the Product-Service Engineering study programme:

- Presentation techniques
- Structure and outline of (engineering) scientific papers
- Writing (engineering) scientific papers
- Project and time management

4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises and practicals	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information: -	
12	Language: German	

Product Development and Requirements Engineering					PQRE
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3309	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	54	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

Students:

- can explain and apply the basic principles of product development.
- can describe and evaluate factors influencing the development of successful products.
- know the product development process and can derive corresponding tasks and processes in the various development phases.
- are able to apply creativity techniques and solution finding methods to create a concept for a product.
- can distinguish between the different design methods and identify the respective advantages and disadvantages.
- describe the categories of requirements and are able to systematically record (specify), formulate and document requirements in a structured language.
- carry out reviews, create questionnaires and evaluate the requirements according to market needs.
- create and evaluate quality metrics, version requirements, and pursue them.

3 Contents:

Product development:

- Product planning, product identification, product innovation process, product development process
- Factors influencing the development of successful products
- Task and concept development
- Selected creativity techniques and solution-finding methods
- Design method and methodical construction
- Perception, interpretation and aesthetics
- Product and process optimisation
- Design Management

Requirements Engineering:

- Categories of Requirements
- Requirements Lifecycle
- Agile processes and requirements engineer
- Creativity techniques

	• Requirements evaluation • Inconsistency management • Requirements specification and documentation • Description in structured language • Inspections, reviews and questionnaires • Quality metrics • Versioning and variants • Change management and traceability • Change management
4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events
5	Participation requirements:
	Formal: -
	Content: -
6	Forms of assessment: Term paper, written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: N. N.
11	Other information: -
12	Language: German

Quality Management					QMG
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3201	150 h	5	4th or 6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- can determine/assess the "value" (cost/benefit) of quality for a company and can understand the development of quality management.
- understand and distinguish between the existing quality management models and can apply quality management systems in a purposeful manner.
- can integrate quality management into existing management structures of a company.

3 Contents:

- The term ‘quality’
- Basics of quality management systems (QMS), tasks and objectives of QMS in the company
- Terms and definitions in quality management
- Analysis of the costs/benefits of a QM system
- Strategies for increasing and ensuring ‘quality’ in the company (PDCA cycle)
- Tools, procedures, means, processes of quality planning, control, inspection and improvement

Prerequisites for the successful use of management systems for quality management in the company
Overarching aspects of quality management: Standardisation, certification etc.

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, written examination, project work or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Digital Logistics (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.

9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. oec. Pascal Reusch
11	Other information: -
12	Language: German

Feedback Control Engineering					RTK
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3125	150 h	5	4th/5th/6th sem.	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

After successful completion of the course, the students will be able to assign the basics from the field of control technology. The students are able to recognise the benefits of control systems in a problem-oriented manner and develop solution strategies. In addition, the students can solve simple control engineering tasks, i.e. find the corresponding controllers and their parameterisation for simple technical processes. Students can resolve and simplify more complicated control engineering structures. In addition, the students can predict the behaviour of the closed control loop on the basis of a mathematical circuit model. In small groups, the students have gained initial experience with the design and implementation of simple controls for simple processes and have implemented and tested them using common simulation software such as MATLAB Simulink.

3 Contents:

Introduction to Control Engineering

- Terms
- Definitions
- Block diagrams

Transmission link analysis

- Steady-state and dynamic behaviour
- Frequency response and floor diagram
- Determining mathematical models for technical systems
- The control loop
- Basic structure of the control loop
- Control loop structures
- Stability behaviour of control loops
- Classical linear controllers
- Simple design procedures
- Parameter-optimal controls

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	
Content:	

6	Forms of assessment: Term paper, written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Michael Leuer
11	Other information: -
12	Language: German

Safety and Security					SAS
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3259	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The students are familiar with various guidelines in the field of functional safety. They are able to carry out a risk assessment and develop a technical safety concept. They have acquired knowledge about different validation concepts and can apply them. The students have an overview of the Machinery Directive as well as the standards IEC 61508 and EN ISO 13849 and have the understanding to apply these to real processes and technical systems.

They are familiar with the most important aspects of IT security and can create vulnerability, threat and risk analyses as well as security plans. They analyse operating system architectures with regard to the protection mechanisms integrated in them. They derive measures and mechanisms to increase reliability. They have a critical understanding of quantitative and provable security. The students can present and advocate their security solutions in an expert panel.

They have comprehensive basic knowledge of legal and data protection and the necessary technical and organisational measures to ensure the legally required data protection.

3 Contents:

Functional safety:

- IEC 61508, ISO 13849
- Machinery Directive and Declaration of Conformity
- Risk assessment, risk analysis, performance level
- Technical safety concept
- Validation concept and traceability

IT security/communication security:

- Basics of computer operating systems (especially internal protection mechanisms and related architectural features)
- Reliability and security objectives (confidentiality, integrity, availability, maintainability)
- Vulnerability, threat and risk analyses and security plan
- Measures and mechanisms to increase reliability and
- Security of software and systems (cryptography, authentication, access control, protocols, firewalls, etc.)

	• Quantitative and provable security • Physical layer security • Methods against jamming Legal and data protection: • Legal basis • Technical and organisational measures to ensure legally required data protection
4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events
5	Participation requirements: Formal: - Content: -
6	Forms of assessment: Term paper, written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Eng. and Product Service-Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: N. N.
11	Other information: -
12	Language: German

Service Engineering					SVE
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3260	150 h	5	4th sem.	Annual (Summer)	1 semester

1

Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
Lecture	60 students	1	SCH	0	h	27	h
Tuition in seminars	30 students	0	SCH	0	h	0	h
Exercise	20 students	3	SCH	24	h	75	h
Practical or seminar	15 students	0	SCH	0	h	0	h
Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

The students have a comprehensive overview in the field of service engineering and can reproduce it. They know the basic terms on the subject of service engineering and can apply them in a technical discussion. They understand the essential principles of service modelling and service development and are thus able to design customised services for the customer or for their company. They develop services using simple examples from practice and apply the methods and processes they have learned. Students are able to describe and explain process models in service engineering. They know the necessary creativity techniques and use them to develop value-added services. With the help of the "service blueprinting" approach, they describe services and shape them at the same time.

3 Contents:

- Introduction to the topic
- Motivation for dealing with service engineering issues
- Clarification of basic terms
- Process models in service engineering
- Relationship between service engineering and quality
- Customer orientation in service engineering
- Identification of innovative value-added services (VAS) with creativity techniques
- Acquisition of development partners with the help of the "lead user" approach
- Description of value-added services with the help of the "service blueprinting" approach
- Development of a service with the methods learned with industrial examples

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, written examination, project work or oral examination

7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: N. N.
11	Other information: -
12	Language: German

Service Communication and Training Concepts					SKTK
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3261	150 h	5	5th or 6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time /classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

The students know basic elements and methods of information management. They have an overview of information products in the company and on the market and can classify and evaluate them. They are familiar with the requirements of database-supported information systems and model the information paths between the customer and the company in a process-oriented manner. They know the definition and delimitation of document, information and knowledge management and are able to actively design the management processes. The students are familiar with the methods and tools of knowledge management, know their prerequisites and areas of application and can use them in the field of service communication and customer training. They know different training methods and can create a training concept. They create training documents and structure them with SGML/XML. The students are able to convey didactically prepared technical contexts in training courses and technical discussions.

3 Contents:

Introduction to Information Management:

- Elements and methods of information management
- Information products in the company and on the market
- (Customer-) process-oriented information modelling

Requirements for database-supported information management:

- Standardisation, granulation, modularisation

Introduction to knowledge management:

- Definition and delimitation of document, information and knowledge management
- Methods, prerequisites and tools of knowledge management

Introduction to SGML/XML as a structuring method for extensive information collections:

- Elements and methods in SGML/XML document creation
- Training methods and didactics

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6	Forms of assessment: Term paper, written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: N. N.
11	Other information: -
12	Language: German

Smart Services and Devices					SMSD
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3262	150 h	5	5th or 6th semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students are able to identify and describe the potential for smart services. They have an overview of the state of digitalisation in the various business areas and know the risks of disruption in the field of digitalisation. Students design smart services on the basis of specifications and can operate and qualitatively evaluate them. They can explain the principles of the different technologies for smart services and are familiar with the conventional integration platforms. Students have an overview of assistance systems, their design and historical development. They know the technological equipment of smart devices and can use this technology for smart services. They design smart services on platforms as well as smart devices and can explain how these smart services work. They can present and evaluate the benefits of smart services. The students have basic knowledge of the communication and networking of smart devices, can establish a connection to the Internet of Things and are able to define the interfaces.

3 Contents:

- Smart Services
- Introduction and Motivation
- Digitalisation and disruption
- Identifying potential for smart services
- Development and specification of smart services service architectures
- Integration Platforms
- Technologies for Smart Services
- Quality and operation of smart services
- Historical development of assistance systems
- Technological enablers for smart devices
- Smart devices
- Technological equipment
- Communication and networking
- User interfaces
- Smart Devices in the Internet of Things

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information: -	
12	Language: German	

Statistics					STAT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3224	150 h	5	3rd or 4th semester	each semester	1 semester

	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
1	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students:

- can explain basic concepts of statistics.
- can apply the basic methods and procedures of descriptive statistics and probability theory.
- are able to analyse economic questions and problems with statistical methods and to show correlations.
- are able to solve tasks with the help of suitable software (SPSS, Excel,...).

3 Contents:

- Descriptive statistics (one-dimensional frequency distributions, measures, multivariate statistics, regression analysis)
- Probability theory (discrete and continuous distributions)
- Statistical inference
- Use of Excel/SPSS

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, written examination, combined examination, project work, oral examination or examination accompanying the course

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Dr. rer. nat. Sabrina Proß

11 Other information:

-

12	Language: German

Technical English					TCE
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3121	150 h	5	1st, 3rd or 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars		0	SCH	0	h	0	h
	Exercise		0	SCH	0	h	0	h
	Practical or seminar	15 students	2	SCH	32	h	46	h
	Supervised self-study	30 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

- Expertise: Students demonstrate that they have extended their active general language competence from B1.2 and achieved a B2.1 level. They possess a sound basic vocabulary of Technical English and master the contextually relevant grammar. They communicate spontaneously and fluently in engineering job situations. They formulate issues confidently, clearly and in detail in English both in speaking and writing
- Social competence: They try out and consolidate communicative key skills in English presentations, teamwork and project work.
- Methodological competence: They use targeted strategies for content acquisition and critical analysis of technical texts and for solving contextual tasks. They can present technical issues in a way that is appropriate for the target group.
- Personal competence: They assume responsibility for their learning process; they research and structure authentic material, organise workloads and meet deadlines.

3 Contents:

- Students master the core terminology of the technical and organisational content of their study programme (e.g. dimensions and shapes; numbers, symbols and mathematical operations; materials and manufacturing; automated systems and Industry 4.0; logistics; international trade, etc.).
- They possess interdisciplinary skills (e.g. emailing; writing reports and abstracts; project pitches; discussing readings and trends; designing conference posters).

4 Forms of teaching:

Seminar-based teaching / individual and group work, etc.
Project task (Assignment)

5 Participation requirements:

Formal:	
Content:	English language competence: B1.2 (according to the European Reference Framework of Languages)

6	Forms of assessment: Combination examination
7	Prerequisite for the award of credit points: 70% attendance and active participation, passed semester project and written exam
8	Application of the module (in the following study programmes) Digital Logistics (work-integrated) B.Eng., Digital Technologies (work-integrated) B.Eng., Mechatronics/Automation (work-integrated) B.Eng., Product-Service Engineering (work-integrated) B.Eng. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: OStR Cornelia Biegler-König
11	Other information: -
12	Language: English

Usability Engineering					UEG
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3263	150 h	5	5th or 6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

The students can explain the basic terms of the topic "Usability Engineering". They know design principles and tools and can apply them. They formulate usability goals and summarise them in the form of design guidelines. They understand the essential principles of human-machine interaction and are able to depict correlations between human information processing, user-friendliness and software ergonomic quality criteria. Students create style guides based on user profiles, design principles and usability goals and can explain and represent them in professional discussions. Students learn techniques of user-centred data visualisation and can use them based on perceptual data and evaluate the psychological aspects of the relationship.

3 Contents:

Introduction:

- Definitions and basic terms
- Fundamentals of user interfaces
- Basic knowledge of human-machine interaction (HMI)
- Basic models of the HMI
- Software ergonomic quality criteria of user-friendliness
- Fundamentals of human information processing

Design guidelines

- User participation, user profile analysis, contextual task analysis
- Usability goals
- Design principles (colour, symbolism, grouping, arrangement)
- Style guide

Process models and methods of usability engineering

- Design principles, tools
- Perceptual psychological aspects of data visualisation Techniques of data visualisation
- Usability testing using video and the style guide
- Illustration of basic knowledge using practical examples from industry
- Evaluation of human-machine interaction systems (evaluation methods, performance measurement, checklists)

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: N. N.	
11	Other information: -	
12	Language: German	

Networking and IoT Solutions					IOT
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3264	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	46	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	1.5	SCH	24	h	0	h

2 Learning outcomes/competences:

Students can name and explain the different layers of the ISO-OSI communication model. They know the intersections between the individual layers and can apply them. They understand the essential processes between the individual communication layers and can name the data abstraction. Students have an overview of industrial fieldbuses, they know the common protocols and can interpret them. They understand the international standardisation of fieldbuses and are able to apply it. The students have basic knowledge in the area of the OPC-UA standard. They know the standardisation and specifications and can implement OPC clients and OPC servers. They simulate different bus systems with appropriate tools and analyse the data packets sent. They can evaluate different bus technologies and classify them for different applications. The students can illustrate the correlations between the bus technologies. They are familiar with the TCP/IP protocol and can use it for IoT solutions (Internet of Things). They know the essential principles of wireless communication and can name and describe their standards. They are able to apply their knowledge in the field of industrial communication and of wireless data transmission to IoT solutions.

3 Contents:

Introduction
Distributed Communication in Industrial Applications
The ISO-OSI Communication Model
Security layer: Access procedures, protocol security, reliability
Switching layer: Routing and device discovery, IP protocol
Transport layer: Providing quality of service
Session layer: Transaction security of unreliable channels
Presentation layer: Character representation and character encoding
Application layer: Application protocols and services

Industrial fieldbuses
International standardisation of fieldbuses
AS-Interface, CAN, Profibus, KNX, DeviceNet, ...
Ethernet-based real-time systems
EthernetIP, EtherCAT, ProfiNet, Powerlink,

IPC Global's standards
OPC-UA Standard

	Wireless Communication Basics Radio Technology Bluetooth, Wifi, IEEE802.15.4, WirelessHART, ... Coexistence of radio systems Peculiarities of the radio channel From point-to-point to multi-user systems From single-hop to multi-hop Wireless sensor networks Body-area networks Infrastructure as a service Spectrum Sharing Cloud Radio Access Networks Full duplex communication	
4	Forms of teaching:	
	Self-study units, exercises and practicals in the form of face-to-face events	
5	Participation requirements:	
	Formal:	-
	Content:	Module "Foundations of Computer Science"
6	Forms of assessment:	
	Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points:	
	Module examination pass and course assessment	
8	Application of the module (in the following study programmes)	
	Digital Technologies (work-integrated) B.Eng. and Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	N. N.	
11	Other information:	
	-	
12	Language:	
	German	

Contract and Liability Law					VHR
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3265	150 h	5	5th or 6th semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	56	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	62	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

Students can explain the distinction between civil law and public law. They can describe the structure of civil law. The students have an overview of the current sources and norms of private law. They understand the essential principles of private autonomy and can assess the limits within the freedom of contract. They know the legal basics of contract drafting and liability law to the extent that they can communicate with legal scholars.
They know the contents and consequences of contractual and liability law stipulations and are able to discuss these with clients.
The students can transfer the knowledge in the field of contract formation to the requirements of their own company and customers and communicate accordingly.
The students know the basic features of product liability law and can classify it in the legal system of Germany. They understand the obligations for producers resulting from product liability and have reviewed and deepened these using practical examples. Students will be able to assess and evaluate the specifics of international cooperation.

3 Contents:

- The demarcation between civil law (private law) and public law
- Structure and basic concepts of civil law
- Sources and norms of private law
- Principles of freedom of contract.
- The formation of the contract (offer and acceptance), the consequences of defects of intention and error as well as rules of representation
- The purchase contract and the employment agreement
- The consequences of non-performance and poor performance
- Basic concepts of liability law
- The tort of negligence, in particular organisational negligence and breach of traffic safety obligations
- Strict liability and product liability
- Special features of international cooperation
- Basics of the law of torts

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment:	
	Term paper, written examination, project work or oral examination	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	N. N.	
11	Other information:	
	-	
12	Language:	
	German	

Sales and Customer Management					VUK
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3255	150 h	5	7th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	67	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	51	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	1	SCH	16	h	0	h

2 Learning outcomes/competences:

After successful completion of this module, students have a deeper level of knowledge in the area of sales and customer competence and can present this.
During the course, students learn methods to analyse distribution systems and processes. This enables them to understand and evaluate strategic and operative sales approaches and to apply them to relevant problems in business practice. They can assess the importance of customer management for the success of a company and know the current methods for determining customer value and instruments for building and maintaining customer relationships. Building on this, they will have the knowledge and skills to analyse methods of customer retention and apply them to new problems.

Students will be able to discuss sales and customer management problems and solutions with experts in their company at an appropriate level. They are able to realistically assess themselves and their impact on clients.

Students are able to relate to others and to think and act in a sales- and customer-oriented way.

Students master basic instruments of sales and customer management. They think in a decision- and system-oriented way and are able to work on problems in the field of sales and customer management in a theoretically sound and structured manner and find an appropriate solution.

3 Contents:

Basics of sales and customer management

Sales management:

- Planning and organisation of sales activities
- Key-figure-based strategic and operative sales planning, management and controlling
- Current challenges in sales

Customer management:

- Situation analysis and target planning of customer management
- Process and instruments of customer assessment, customer segmentation, and customer integration in the value creation process

	• Elements of CRM and operational CRM • Electronic Commerce
4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events
5	Participation requirements:
	Formal:
	Content:
6	Forms of assessment: Term paper, written examination or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Prof. h.c. Lothar Budde
11	Other information:
12	Language: German

Elective Module: Product-Service Engineering					WM
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
9017	150 h	5	5th or 6th semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students		SCH		h		h
	Tuition in seminars	30 students		SCH		h		h
	Exercise	20 students		SCH		h		h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students		SCH		h		h

2	Learning outcomes/competences:	
3	Contents:	
4	Forms of teaching:	
5	Participation requirements:	
	Formal:	
	Content:	
6	Forms of assessment:	
7	Prerequisite for the award of credit points:	
8	Application of the module (in the following study programmes) Product-Service Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
10	Module coordinator: N. N.	
11	Other information:	
12	Language: German	